

# BULLETIN

OF THE

## BROOKLYN ENTOMOLOGICAL SOCIETY

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VOL. XXX

DECEMBER, 1935

No. 5

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### PRESOCIAL BEHAVIOR AMONG THE HEMIPTERA.

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It is now generally understood that social habits have arisen repeatedly and independently among different groups of solitary insects. Although the incentive which conditioned the emergence of social behavior need not have been the same in all cases, it appears nevertheless that all insect societies originated in much the same fashion and consequently have a similar fundamental structure. As W. M. Wheeler expresses it, each insect society "is a family consisting of two parent insects and their offspring or at least of the fecundated mother and her offspring, and the members of the two generations live together in more or less intimate, coöperative affiliation." Since the parent-offspring relation lies at the root of all insect social life, a study of this relation among solitary insects should throw some light upon the evolution of social behavior.

Much attention has been paid recently to the incipiently social, or *subsocal*, insects. In these forms, the newly hatched young stay with both or one of the parents for a limited time, being fed meanwhile; each of the offspring, however, is wholly or primarily interested in itself and little or none in the welfare of the community. Subsocial habits evidently arose from a more primitive familial relation, now exhibited by insects in which one or both of the parents merely guard the offspring temporarily, without providing it with food, a type of behavior which may conveniently be called *presocial*. The term *infrasocial* might then be restricted to the numerous species of insects that leave the eggs or newly born larvae to their own fate, although the female may display more or less ingenuity or foresight during oviposition.

Presocial habits are observed as exceptions in several unrelated groups. They are not even confined to insects, since they are exhibited also by scorpions and some spiders. For some time I have

been gathering material for an account of parental solicitude among the true Hemiptera or Rhynchota, an order in which a number of interesting cases have come to light in recent years. It is to be expected that many more will be added, when these much neglected insects are adequately observed in the tropics.

Dr. R. F. Hussey recently (1934) presented a review of this topic and I do not intend duplicating his paper. I shall merely offer a revised list of the known cases, arranged systematically, with additional information on some that are new or little known. The appended bibliography is, however, complete, since no satisfactory list of papers dealing with parental care in Hemiptera has been published for the past thirty years.

Moreover, a renewed discussion of parental care among hemipterous insects is by no means amiss. Some of the most authentic cases are regarded with suspicion or even discredited in certain quarters, apparently following Fabre's (1901 and 1903) unfortunate blunder with regard to *Meadorus* (or *Elasmothethus*) *griseus*. Even in H. Weber's recent "Biology of the Hemiptera" (1930), this matter is inadequately treated.

I do not include among the cases of presocial behavior reported below, any of the Belostomatidae, in which the adult males carry the eggs on the back during the incubation period. It has been shown that in these insects the female forcibly seizes another individual of the same species (usually a male, more rarely a female), on whose back she lays the eggs. These egg-carrying individuals can therefore hardly be regarded as evincing parental solicitude or even interest in the offspring. The case of *Phyllomorpha laciniata* (Villers) (Coreidae), of southern Europe, is excluded for the same reason. In this insect also the eggs are placed loosely by the female on the concave back of the male, where they are kept in place by a series of slanting spines, until the nymphs hatch.

## RHYNCHOTA.

(Hemiptera Heteroptera.)

### SCUTELLERIDAE.

The earliest observation of insects of this family caring for the offspring, was by Father A. Montrouzier (1855; translated by Kirkaldy, 1902), in Woodlark Island, off the eastern coast of New Guinea. He seems to have observed this behavior for several species, but he mentions none by name and no observations have since

been made tending to clear up their identity. Quite possibly one of his species was a *Cantao*, since he describes in the same paper (p. 93) *Scutellera variabilis*, a species now placed in that genus.

*Tectocoris diophthalmus* (Thunberg) (Syn.: *T. lineola* Fabricius), of the Oriental and Australian regions, was observed by F. P. Dodd (1904) and by E. Ballard and F. G. Holdaway (1926), in Queensland. The female attaches the eggs in a mass to an upright twig and usually stands over them until they hatch. If she leaves them, she will be found close-by and the brooding may last as long as 17 days. She attempts to protect the eggs against chalcid parasites. K. C. McKeown (1933) merely cites Dodd's observations.

*Cantao ocellatus* (Thunberg), of the Oriental Region, was repeatedly observed in India guarding the eggs and young nymphs (see H. Maxwell-Lefroy and F. M. Howlett, 1909; T. B. Fletcher, 1914; T. V. Ramakrishna Ayyar, 1920). R. Takahashi's (1921) elaborate study of this insect in Formosa was published in Japanese. Some years ago I had a translation made of his paper, so that I now can make his observations more generally available. I quote from him:

"With the tip of her abdomen the female lays ten or twenty or more eggs on the under side of the leaves of certain trees. Generally eggs of Hemiptera are not white, but those of *Cantao ocellatus* appear so. The female oviposits only once and the eggs are placed in a single row. After she has laid the eggs, she places her abdomen over them, extends the antennae forward and stays there without moving, never leaving the spot even for a walk. She never takes food once the eggs are laid. Before they lay eggs, the females walk a good deal; sometimes they jump, at other times they keep quiet. When the insect is not moving or walking, it easily drops to the ground if touched with the point of a pin. After oviposition the female becomes dormant and never leaves the spot where the eggs were laid until she dies.

"If approached, she moves her legs and antennae a little, and if touched with a pin or other object, she moves her body a little, but she never walks away nor drops to the ground. I have moved the antennae and legs and pressed them with a pin in many specimens, but they never left the spot and clung to the eggs. The female frequently lifts her head while sitting on the eggs, and sometimes she moves her legs to the left and the right and cleans her antennae.

"The egg hatches about eight days after it has been laid. A group of eggs hatch at the same time. This is because

when one egg hatches, the movements of the young nymph cause the other eggs to hatch. The female never moves from the spot and stays there even after the eggs have hatched.

"After the eggs have hatched the nymphs remain in the egg shells and do not take food nor move about. In other words, the nymphs stay under the maternal body. They undergo two moults within about six days; a few days later they begin to move about together, leaving the egg-shells and looking for food. This then ends the maternal protection, the nymphs feeding after the second metamorphosis.

"The female stays on the same spot until she dies, even after the eggs have hatched and the nymphs are scattered. The cause of death is, of course, hunger. A few females even die before the eggs hatch. In this case, after the female's death, the male never attempts to take care of the eggs, but these hatch just the same without difficulty."

Takahashi also describes experiments showing that a female, removed from her own batch of eggs, will readily adopt a batch of strange eggs or of strange young nymphs and even a batch of hatched, empty egg-shells. If placed on a leaf, away from eggs or larvae, she usually remains on the spot in a dormant condition and does not attempt to search for eggs or nymphs. Under such conditions, however, a female may sometimes wander away and if she then meets with eggs or nymphs, she does not attempt to take care of them. A female which has not yet oviposited cannot be induced to stay with eggs or young nymphs. The author concludes that "the female of *C. ocellatus* cannot discriminate between her own eggs or nymphs and those that belong to another female and that in fact all females become dormant after the eggs are laid."

Ramakrishna Ayyar's rather inaccessible account is as follows:

"This insect is one of the few and interesting examples of insects exhibiting what may be called 'parental care.' The mother-bug sits on the eggmass and continues to do so from the time the eggs are deposited until after they hatch out into young ones. In some cases I have observed the mother remain in the same position some time even after all the young larvae have moved away from beneath her body. All this time the parent insect does not take any food and while in this posture the slightest disturbance makes it vibrate the antennae in a characteristic manner as though in defence, and bring its body closer to that side of the eggmass where the disturbance is felt. The eggmass in some cases is fairly big and the parent is not able to cover the whole mass while it sits over it. In one case where I got a group of eggs collected from a tree with

the mother mounting guard over them, I observed that, while those eggs well covered by the parent's body retained their normal colour, those at the edge and away from the mother's reach developed a dark tinge and eventually, in about two days, minute black wasps emerged from the eggs instead of bug larvae. Evidently the parent resting on the eggmass serves to some extent as a preventive against the eggs getting parasitized."

*Pachycoris fabricii* (Linnaeus), of the West Indies, was briefly mentioned by H. G. Barber (1925). Mr. Barber has sent me a more detailed account read before the American Association for the Advancement of Science, but apparently as yet unpublished. I quote from this manuscript, with Mr. Barber's permission:

"While collecting insects in Porto Rico for the American Museum of Natural History, in the summer of 1914, I noticed a specimen of the brilliantly colored female of this species on the under side of a leaf. Spread over the leaf surface were quite a number of the small dark green nymphs, probably in the second instar. I slightly disturbed the leaf, when suddenly to my great surprise the little bugs scurried to the mother, crowding beneath her robust body in order to gain protection. The mother bug seemed perfectly conscious of her duty in the matter and remained stationary, covering them over with her body very much as a hen will hover her chicks. No eggs were found on this particular leaf, so that the brood must wander about in the wake of the mother, at least to some extent. As the nymphs observed were only eight or ten in number, it is quite evident that some of the brood had either gone astray or had perished."

*Pachycoris torridus* (Scopoli), of Central and South America, was observed by R. F. Hussey (1934) in Paraguay. The female deposits 50 to 150 eggs in a flat plaque on the under side of a leaf and stands guard over them throughout the period of incubation and the first nymphal instar. The plaque of eggs usually occupies an area just about as great as can be covered by the adult bug and, after emergence, the young huddle in a mass under the body of the female. Presocial behavior in *P. torridus* had been observed previously, however, by E. G. Smyth (1919), in Porto Rico.

#### PENTATOMIDAE.

*Meadorus griseus* (Linnaeus), of Europe, also variously referred to as *Elasmotethus griseus*, *Clinocoris griseus*, *Acanthosoma griseum*, *Elasmucha interstincta* Reuter, and *Cimex betulae*

Degeer, is the oldest and best-known case of parental care in Hemiptera. It was first observed by Modeer (1764), whose Swedish account was translated into German by Herbst (1786). Carl Degeer (1773 and 1780) studied this insect very carefully, calling it "*Cimex betulae*." Since then it was observed by P. Boitard (1836), E. Parfitt (1865), J. Hellins (1870, 1872, and 1874), F. Reiber and A. Puton (1876), Pierre (1903), H. Schouteden (1903), A. C. Oudemans (1905), W. C. Jensen-Haarup (1916 and 1917), F. Schumacher (1917), E. Nielsen (1920), and T. Schoevers (1925). Most of these observations have been summarized by G. W. Kirkaldy (1903 and 1904), H. Schouteden (1903), R. Heymons (1915), E. A. Butler (1923), and H. Weber (1930). All observers agree that in this species the female guards the eggs after oviposition and remains with the young larvae for as long as 19 days. Not the least interesting behavior of females guarding eggs, is that they do not give off the characteristic bug-odor emitted by the insect under ordinary circumstances.

*Phlaeophana longirostris* (Spinola) (Syn.: *Phloea paradoxa* Burmeister, 1835) was studied with much detail near Rio de Janeiro, Brazil, by P. S. de Magalhães (1909 and 1910) and by P. Brien (1923 and 1930).<sup>1</sup> The female lives closely applied to the bark of *Terminalia Catappa* Linné, where she readily escapes detection. She covers with her body 8 to 12 eggs; after these hatch the nymphs cling to the under side of her abdomen until they reach the last nymphal stage. Since the proboscis of the early nymphal instars is too short to pierce the bark, these nymphs are probably fed by the mother, either with some substance she excretes or with some of the sap of the tree oozing out along her proboscis.

*Phloea corticata* (Drury) (Syn.: *Phloea paradoxa* Hahn, 1834), of Brazil, has apparently habits similar to those of *P. longirostris*. J. C. Schiödt (1844) found the young nymphs attached to the venter of the female. A third species, *Phloea subquadrata* Spinola, also of South America, should likewise be investigated.

<sup>1</sup> Both de Magalhães and Brien name their insect correctly *Phloea paradoxa* Burmeister, 1835 (not of Hahn, 1834). The insect should, however, be known as *Phlaeophana longirostris* Spinola (1837), on account of the earlier *Phloea paradoxa* Hahn (1834), even though the latter is a synonym of *Phloea corticata* (Drury, 1773). P. S. de Magalhães's first account was reproduced by R. v. Ihering (1909), H. Kolbe (1910), and (in English) by R. F. Hussey (1934). His later paper, published in 1910, is, however, much more complete.

*Chlorocoris atrispinus* Stål (identified by Mr. H. B. Barber).—On February 5, 1931, at the Finca Pacayal near Pochuta (Dept. Chimaltenango), Guatemala, I observed a female of this large green bug (21 mm. long). She was quietly resting on the under side of the frond of a tree-fern grown on the porch of a house. She made no attempt to escape when disturbed and when I caught her, I was much surprised to find fifteen small nymphs hiding under her body. These nymphs were all about the same size (3.5 to 4 mm. long) and apparently in the first instar. They were very quiet, all huddled together in one layer, and so completely covered by the mother, that at first their presence was not even suspected. Since they were sitting over the empty egg-shells, fixed to the frond, it may be surmised that they had recently hatched and had not yet started to feed. This observation shows clearly that the female of *Chlorocoris atrispinus* guards the eggs as well as the young nymphs.

*Garceus fidelis* Distant was observed by F. P. Dodd (1916), in northern Queensland. He states that the larvae "shelter upon the under side of the abdomen of their parent. I have often met with this bug, but when I did come across a mother with young they were never on the leaf, though I suppose they come down to feed."

*Eumecopus*.—An unidentified species of this genus was found by F. P. Dodd (1916), in the Cairns district of northern Queensland, staying with ova and larvae.

In the case of *Coctoteris exiguus* Distant, of New Guinea (Kirkaldy, 1903 and 1904; referred to a species of *Spudaeus*? in 1902), and of *Mecitorhinus* (or *Dinocoris*) *tripterus* (Fabricius), of Central and South America (P. Rau, 1918), the evidence is extremely meagre. These insects cannot yet be included among those definitely exhibiting parental solicitude.

#### ARADIDAE.

According to H. E. McClure (1932), the female of *Neuroctenus pseudonymus* Bergroth, in Texas, lays the eggs in masses of from 10 to 50 in channels burrowed by other insects under the bark of dead trees. She then departs, but another adult crawls astride the eggs and remains there until they hatch. McClure is probably right in his surmise that this second individual is a male, since I found that only the male guards the eggs in the African reduviids, *Rhinocoris albopilosus* and *R. albopunctatus*.

*Ctenoneurus hochstetteri* (Mayr) was observed by J. G. Myers (1921), in New Zealand. He notes that imagines "are sometimes found carrying several first or second instar nymphs on their backs

and sides in a manner comparable to that of Lycosid spiders. Considering the gregarious habit of the species, perhaps we should rule out maternal solicitude as an explanation; but it is significant that these young nymphs do not apparently cling to older nymphs which closely approach imagines in size."

#### REDUVIIDAE.

In a South American, undetermined species of *Ghilianella*, according to F. Pascoe (1888; quoted by D. Sharp, 1909, p. 556), the linear shape enables the young nymph to be carried about by the adult. The long, slender abdomen of the larva is curled around the thorax of the parent; but the sex of the adult caring for the young is not known. Pascoe's observation was made at Pará, Brazil.

*Endochus cingalensis* Stål "and allied forms" were observed by E. E. Green (in Kirkaldy, 1904, p. 583), in Ceylon, remaining near their egg clusters until they are hatched. "The young are at first gregarious, and the parent may usually be seen on the same leaf, watching over them like a hen with her chicks. It seems possible that she may catch insects to provide them with food, but I have no evidence of this."

*Rhinocoris albopunctatus* Stål is a common reduviid in South Central Africa, particularly in the Katanga District of the Belgian Congo. I found it on several occasions, near Bukama and Sankisia, guarding the egg-mass attached to a stem (J. Bequaert, 1912 and 1913).<sup>2</sup> The young nymphs also remain with the adult for some time after hatching. In each case it was the male, not the female, that took care of the offspring. Similar observations were made on the related *Rhinocoris albopilosus* Stål, during my later journey through the northeastern Belgian Congo. At Penge, on the Ituri River, I found, on February 15, 1914, one of these reduviids guarding the eggs as I have described for *R. albopunctatus*. The adult

<sup>2</sup> The insects observed in the Katanga in 1911-1912, were originally named *R. albopilosus* Stål and recorded under that name in my two notes of 1912 and 1913. In his recent Catalogue of the Reduviidae of the Belgian Congo (1932, Ann. Musée du Congo Zool., Série II, Section II, I, fasc. 3, p. 171), Dr. H. Schouteden refers all Katanga specimens to *R. albopunctatus* Stål, while retaining the name *R. albopilosus* for the specimens of the Lower, Central and Northeastern Congo. He states, however, that the two species are closely related, which is also brought out by the fact that they exhibit the same presocial behavior.

in this case too was a male and most careful search failed to disclose any female near-by. The male was sitting on top of the eggs, none of which were hatched. I succeeded in forcibly pushing him away from the egg-mass, but he always returned to the eggs after a while. When an ant was thrown onto the egg-mass, the male at first moved away, evidently frightened by the moving hand; but he soon returned, carefully exploring with the antennae, until the ant was discovered. The bug then proceeded to attack the ant with the beak and finally impaled it and carried it off an inch or so from the egg-mass, where he dropped it and then returned to the eggs. It seems rather remarkable that parental solicitude has not been reported for any other of the numerous African species of *Rhinocoris*.

#### TINGIDAE.

In two North American species of *Gargaphia*, the female is definitely known to guard the eggs and young nymphs.

D. E. Fink (1915) first observed this behavior for *Gargaphia solani* Heidemann, in Virginia. I quote from his account:

"The female attends the eggs during the entire period of incubation, leaving them only at intervals to feed, and later, when the nymphs emerge, is constantly in attendance. . . . When migrating from one leaf to another the female adult usually directs the way and with her long antennae keeps the nymphs together or rebukes any straggler or deserter. It is an interesting sight to observe the migration of a colony of more than a hundred nymphs, with the female adult hurrying from one end of the flock to the other, keeping them together and at the same time urging them in the right direction during the migration. . . . On one occasion while observing the feeding of the nymphs, a ladybeetle (*Hippodamia convergens* Guér.) was seen to approach the brood, when the adult lacebug in attendance on the nymphs, with outstretched, slightly raised wings, suddenly darted toward the intruder, driving it from the leaf."

According to observations by H. B. Weiss (1919), in Pennsylvania, and by J. R. de la Torre-Bueno (1935), in New York, *Gargaphia tiliae* (Walsh) has similar habits. Weiss writes: "During the incubation period of the egg, a female lacebug is always in attendance and each colony of nymphs usually has a female watching over it until the members are full grown."

## CYDNIDAE.

*Schirus sexmaculatus* Rambur, of Europe, was observed by F. B. Boselli (1932), in Italy. He found that the female lays underground, in a small niche, a compact mass of 100 to 125 eggs which she keeps grasped with the legs. To these she is very devoted, not attempting to escape when disturbed. If removed from the eggs, she appears uneasy until she regains possession of them, when she proceeds to tuck them under her body. The newly hatched nymphs remain with the mother throughout the first stage. Second stage nymphs, however, were found in the open, away from the mother.

## GERRIDAE.

The genus *Halobates* is unique among the Hemiptera, in that the nymphs and adults live on the surface of the ocean, away from the coast. Several species have been described, mostly from tropical and subtropical waters. D. Sharp (1909, pp. 552-553) gives an excellent résumé of their habits:

“When the sea is calm these insects skim over the surface with rapidity, but disappear as soon as it becomes agitated. They are believed to feed on small animals recently deceased; Witlaczil says on the juices of jelly-fish. The young are frequently met with, and there can be no doubt that the whole life-cycle may be passed through by the insect far away from land. The Italian ship *Vestor Pisani* met with a bird's feather floating on the ocean off the Galapagos Islands, covered with eggs which proved to be those of *Halobates* in an advanced state of development. It was formerly believed that the female carries the eggs for some time after their exclusion, and although this has been denied,<sup>3</sup> it is nevertheless an undoubted fact, for it was observed by Mr. J. J. Walker (Ent. Mo. Mag. XXIX, 1893, p. 227) to whom we are indebted for a specimen having the eggs still attached to the body, as shown in Fig. 265. Mr. Walker believes the bugs shelter themselves when the sea is at all rough by keeping at a sufficient distance below the surface; they can dive with facility and are gregarious. They are frequently found close to the shore, and Mr. Walker has even met with them on land.”

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<sup>3</sup> V. L. Kellogg (American Insects, 1908, p. 198) says that they “probably attach their eggs to floating seaweed (Sargassum).”

#### BELOSTOMIDAE.

*Lethocerus americanus* Leidy, the giant water-bug, seems to exhibit true parental solicitude. According to W. E. Hoffmann (1924), J. R. Parker observed the adults guarding the eggs on the margin of a small slough at Ronan, Montana. When he approached the eggs, the male started for the water; but the female assumed a fighting attitude, with the fore pair of legs extended and ready to strike at anything brought near her.

#### AEPOPHILIDAE.

*Aëpophilus bonnairei* Signoret is a peculiar semi-aquatic bug, living under stones on the coast of western Europe, below high-water mark. J. H. Keys (1895 and 1914; reproduced by E. A. Butler, 1923) observed many of its habits. He states:

"Instinctive solicitude for the young is much in evidence with the species. It was common to see in my breeding cage, on the under side of the stone, a circle of young with an adult in the centre, the heads of the immatures being all oriented towards this centre. On my lifting out the stone, the adult would almost instantly alarm the young with a rapid tap with each antenna alternately, and the whole troop would scamper round to the other side of the stone with great speed."

#### HOMOPTERA.

##### MEMBRACIDAE.

There appears to be only one fairly authenticated case of parental care in the Homoptera. According to R. H. Beamer's (1930) observations, in the North American membracid, *Platycotis vittata* (Fabricius), the female sits on a twig some distance below the cluster of small nymphs, which she guards. She was even seen defending them against a wasp.

The supposed case of maternal affection in the North American *Entylia sinuata* (Fabricius), reported by Mary E. Murtfeldt (1887), is discredited by W. D. Funkhouser (1917, p. 398).

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